The Evolution of Animal Diversity

What is an Animal?

Animals are eukaryotic, multicellular heterotrophs that lack cell walls.

- Eukaryotic: not bacteria (true nucleus)
- Multicellular: unlike most protists
- Heterotrophs: unlike plants, like fungi
- Lacking cell walls: unlike fungi, plants, some protists

Most animals ingest their food, have an internal digestive tract, are diploid, and have unique embryonic stages. NO ALTERNATION OF GENERATIONS.

Origin of Animals

Animals are thought to have evolved from colonial protists. The colony may have formed a hollow ball of cells, some cells specialized and folded inward, eventually producing a protoanimal. These stages represent the embyronic stages that many animals have during development.

Key Traits of Animal Diversity

1. Symmetry is the degree to which different sides of something match each other if we split them in two.

- Radial (round) symmetry = can cut an organism in a variety of places down it's axis, and it is always perfectly symmetric (e.g., sea star, pizza).
- Bilateral symmetry = only a single cut will divide the organism into two identical halves; all other cuts are asymmetric. Most animals (e.g, fox).
- Bilaterally symmetric animals typically have a head housing sensory structures and the mouth, are very active and move head first. In contrast, radially symmetric animals lack a head, forward orientation of the body, and spend most of their time either remaining still or floating with ocean currents. Bilateral symmetry was an important point in evolution, providing the ability to move forward in a directed way.

2. Body cavity: a fluid-filled space between the digestive tract and the body wall.

- Flatworms lack body cavities.
- Roundworms have a pseudocoelom (false hollow), which is in direct contact with the digestive tract, and keeps a space between the digestive tract and the muscle wall. Most animals have a true coelom, which is more complex; it is completely lined with muscle tissue, which wraps around the digestive tract. This suspends the digestive tract and other organs from the body wall.
- Body cavities were an important evolutionary step. They allow organs to grow and move independent of the body wall. The fluid helps to cushion organs and prevent injuries. In some species the body cavity acts as a watery skeleton against which the muscles can move the body. It also helps circulate nutrients.

3. Segmentation is the sudivision of the body into a series of repeated parts (segments; e.g., earthworm, humans [backbone, muscles]). Segmentation allows body flexibility and mobility, and may have evolved as an adaptation for movement.

4. Digestive system: absorbing nutrients and excreting wastes. Some species don't have a digestive system, and take in nutrients directly through their cells. Others have an incomplete digestive system in which they take in food particles through their mouth, but there is no anus and waste comes back out their mouth. A complete digestive system has a true anus, and food travels one way. In a complete digestive tract, the front end mixes food with digestive enzymes, and the rear end absorbs nutrients and disposes wastes

Animal Diversity

Table 1. COMPARISON OF ANIMAL DIVERSITY

Phyla	Symmetry	Body	Segmented	Digestive Cavity Tract	
SPONGES	none	none	no	none	A
CNIDARIANS	radial	none	no	incomplete	B
FLATWORMS	bilateral	none	no	incomplete	C
ROUNDWORMS	bilateral	pseudo coelom	no	complete	D
MOLLUSKS	bilateral	coelom	no	complete	E
ANNELID WORMS	bilateral	coelom	yes	complete	F
ARTHROPODS	bilateral	coelom	yes	complete	G
ECHINODERMS	Both[1]	coelom	no	complete	H
CHORDATES	bilateral	coelom	yes	complete	I

[1]Echinoderm larvae are bilateral, adults are radial.
Other:
A: Most like the "protoanimal".
B: Jellyfish, coral, hydra; cnidocytes used to capture prey.
C: Some are parasitic.
D: Decomposers and parasites.
E: Mussels, snails, etc.
F: Revitalize soil, also parasites.
G: Crabs, insects; jointed appendages, exoskeleton.
H: Starfish, sea urchins; endoskeleton.
I: Four important traits:
1. Dorsal, hollow nerve cord; 2. Notochord; 3. Gill structures; 4. Tail posterior to anus.

Sponges are aquatic animals that are mostly marine. Lack symmetry, no8 body cavity, no segmentation. Among8 the simplest animals, and not far from the protoanimal. No digestive tract, lack nerves and muscles. Have tubes which siphon water, bringing food and nutrients.

Cnidarians include jellyfish, hydras, and corals. More complex than sponges. Radially symmetric, no body cavity or segmentation, but some specialized tissues. Use tentacles to capture prey, using cnidocytes (stinger cells), which grab and stings prey. Incomplete digestive system.

Flatworms are leaflike or ribbonlike animals, bilaterally symmetric, no body cavity, not segmented, incomplete digestive tract. Many are parasitic on other animals, including humans (tapeworms).

Roundworms (nematodes) are cylindrical worms, bilaterally symmetric, pseudocoelom, not segmented, complete digestive tract. Important decomposers in soils and on the bottoms of lakes and oceans, but others are pests or parasites.

Mollusks (soft body) include snails, clams, squids. They have soft bodies protected by a hard shell (usually). They are bilaterally symmetric, true coelom, no segmentation, ciomplete digestive tract.

Annelid Worms (segmented worms) are the first segmented animals. Have a coelom, bilaterally symmetric, complete digestive system. Live in soil or aquatic habitats. Most are scavengers. E.g., earthworms, important for tilling and improving soil, and leeches, common freshwater parasites.

Arthropods (jointed foot; crabs, spiders, and insects), are the most numerous and widespread of all animals. There are more arthropods on the planet than any other group of animal (most of these are insects). Arthropods are segmented, coelom, bilaterally symmetric, and complete digestive tract. Have jointed appendages, and entire body is covered with an exoskeleton (hard, external skeleton), which provides protection and a point of muscle attachment. To grow, arthropods must periodically shed or molt the old exoskeleton and secrete a new one.

Echinoderms (spiny skin; sea stars, sea urchins). Very different from other groups. They have a coelom, but are not segmented. Adults are radially symmetric, while larval forms (juveniles) are bilaterally symmetric. Because of this, we know they are a separate evolutionary line from those groups that never show bilaterally symmetry. Also unique because they have an endoskeleton of bony plates and a unique water vascular system which they use to move & hunt. Echinoderms are most closely related to the chordates, based on embryonic development.

Chordates are segmented, bilaterally symmetric, coelom, and a complete digestive tract. Four characteristics which appear in either the embryo or adult of all species: 1. dorsal, hollow nerve cord (nervous tissue along back) 2. notochord (flexible rod located between the nerve cord and digestive tract); 3. gill structures 4. a tail posterior to the anus. All chordates, including humans, have these traits at some point in their development. The most diverse group of chordates are the vertebrates, which have a backbone. All other chordates, and animals, are invertebrates.

Evolution of Vertebrates

Vertebrates are chordates that have a skull and a backbone, which enclose and protect the nervous system. The skull encloses the brain; the backbone of segmented vertebrae encloses the nerve cord. Other skeletal parts support the body. This endoskeleton of vertebrates is made either of flexible cartilage (nose) or a combination of hard bone and cartilage. Bone and cartilage are mostly nonliving, but part is living and thus the skeleton can grow (unlike an arthropod). The evolution of jaws was another key adaptation for vertebrates. Jaws evolved from bony gills, and allowed vertebrates to eat a variety of prey.